CHARLES UNIVERSITY IN PRAGUE

FACULTY OF PHYSICAL EDUCATION AND SPORT

DEPARTMENT OF PHYSIOTHERAPY

Physiotherapy treatment of patient after microdisectomy of L4/L5

Bachelor's Thesis

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ABSTRACT

Title of the thesis: Treatment of a Patient after microdiscectomy of L4/L5

Thesis aim: This thesis involves a case study approach regarding to a patient after microdiscectomy of L4/L5. The thesis is divided into theoretical part which describes the anatomy and physiology of vertebral column and intervertebral disc. It also contains surgical and rehabilitation approach. The second is a health chart which contains the procedures I have done with my patient, all the examinations, conclusions, therapies and results.

Methods: The practical part is based on a female patient of age 32, after microdiscectomy of L4/L5. The study consists of the initial kinesiologic examination, 4 practical therapy sessions and 3 theoritical sessions. It consist also the final kinesiologic examinations. All methods used were non-invasive.

Result: After the therapy sessions my patient had a progress. Range of motion was increased, muscle tone and length was improved. The therapies have shown to be very effective concerning my patient's diagnosis.

Keywords: Lumbar disc herniation, intervertebral disc, physiotherapy, rehabilitation, surgical treatment

DECLARATION

I declare that this bachelor thesis was handled by me, under the supervision and instructions of my supervisor Mgr. Helena Vomačková. It is an original research, which refers on practice with patient after microdiscectomy of L4/L5 under the supervising of Mgr. Barbora Grmanová. My practice took place at Ústřední vojenská nemocnice, in Prague.

I also state that all the information, examination and therapeutic procedures, which are presented on this bachelor thesis, were performed based on my knowledge that I received from the professors of the Charles University in Prague. The information that I used to write this bachelor thesis was sourced from the list of literature, which exists at the end of the thesis.

Finally, I declare that no invasive methods were used during my clinical practice and that the patient was fully aware of the examinations and therapeutic procedures at any time.

Prague, December 2016 **Evangelou Angela**

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Also special thanks to Mgr. Barbora Grmanov, who was my supervisor in Ustřední vojenská nemocnice, who helped me to complete the practical part of my bachelor thesis.

Special thanks to my friend Nasser Alotaibi who was next to me supporting me and believing on me. Also special thanks to my friend Giannis Hadjigiannis for helping me a lot.

DEDICATION

I dedicate this Thesis to my family for giving me the opportunity to study and all the support during my studies in Charles University and never letting me to give up. I also dedicate it to my friend Nasser Alotaibi who was next to me these years.

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1. INTRODUCTION

My physiotherapy program took place in Ustřední vojenská nemocnice in Prague.

The objective of this thesis is to treat and demonstrate the physiotherapeutic approach in a patient after microdiscectomy of L4/L5.

My thesis is divided into two parts, the general part and the special part (case study). The general part consist the theoretical knowledge of intervertebral disk herniation.

The special part is the most important part of my research and it includes: the examination, treatment, evaluation of effectiveness of the therapeutic procedure and its results.

I used physiotherapeutic procedures from the knowledge i have from my studies, information from book literature and guidance by my supervisors.

2. GENERAL PART

2.1. Anatomy of the spine

First of all spine has three basic functions which are supporting the body,protect the spinal cord and spinal nerve roots and is also important for the movement of trunk.

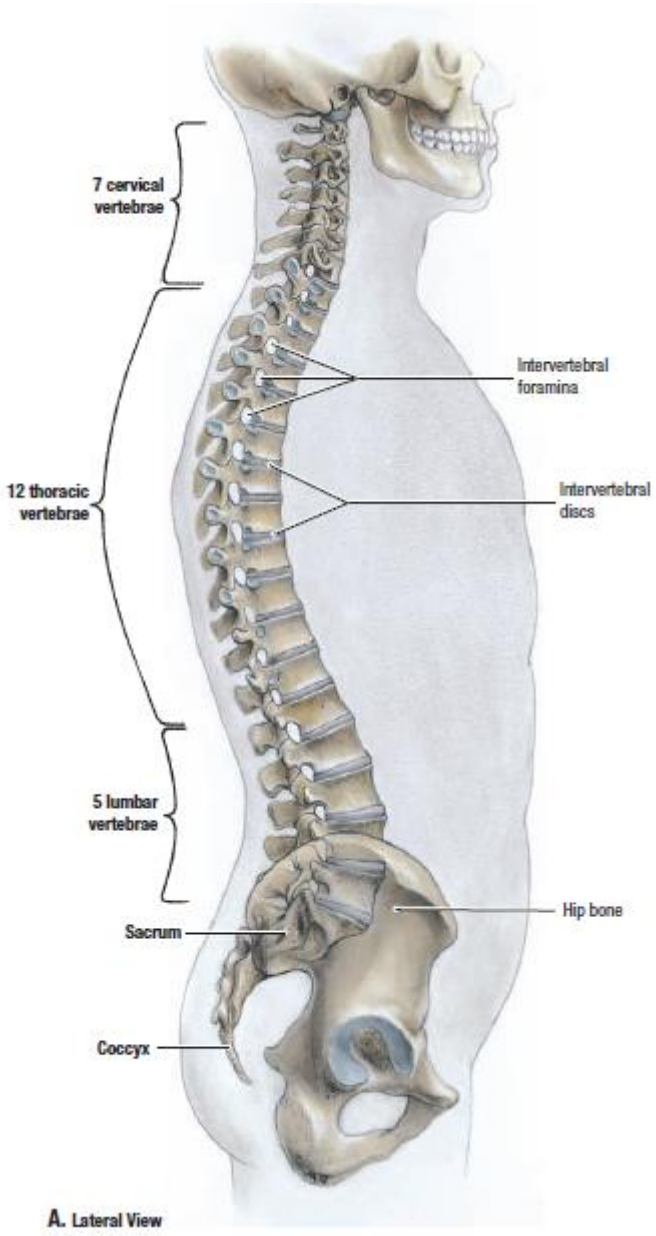
Spine has four anterior to posterior curves. Two are the primary curves which are kyphosis curves and include pelvis and thoracic curvatures. They called primary curves because they are first developed from the early stages of fetal development. Thoracic curve extends from Th2-Th12 and pelvic curve extends from lumbosacral articulation through sacrum to the tip of coccyx. Lordosis curves are the two secondary curves and include cervical and lumbar curvatures. Kyphosis and lordosis along with intervertebral disc are essential for absorbing the loads applied to the spine.

The vertebral column consists of individual bones known as vertebrae, and there are approximately 33 vertebrae.

- 7 Cervical vertebrae (C3-C7)
- 12 Thoracic vertebrae (T1-T12)
- 5 Lumbar vertebrae (L1-L5)
- 5 Postnatally fused sacral vertebrae (S1-S5)
- 3-4 Rudimentary coccyx vertebrae (Co1-Co4)

All vertebrae except atlas and axis consist of the same structural element the vertebral body, superior and inferior articular process, transverse and spinous process and the vertebral arch that include pedicle and lamina. On the surface of the articular processes exists smooth hyaline cartilage-based joint surface which articulates the superior articular process of vertebrae articulation with the inferior articular process and it forms the zygapophyseal joint. Zygapophyseal joints are also named facet or apophysial joints. Their location is posteriorly and they are also known as posterior intervertebral joints. They are small joints and allow motion to occur. The 5th lumbar vertebra articulates with the sacrum and the apex of sacrum articulates with the coccyx. The vertebral body is designed for weight bearing function of the vertebral column. The flat surfaces of its body in superior and inferior part are essential for supporting longitudinal loads. The load bearing of the vertebral structure is also reflected in its internal structure. The body of vertebrae is formed by transverse and vertical trabecular which are the reason for preventing deformation or collapsion of the vertebral body.

When the load is acting on the vertical trabeculae, it tries to bear the load, and if they attend to bow then, the horizontal trabeculae prevent it. [1,11,14,22]



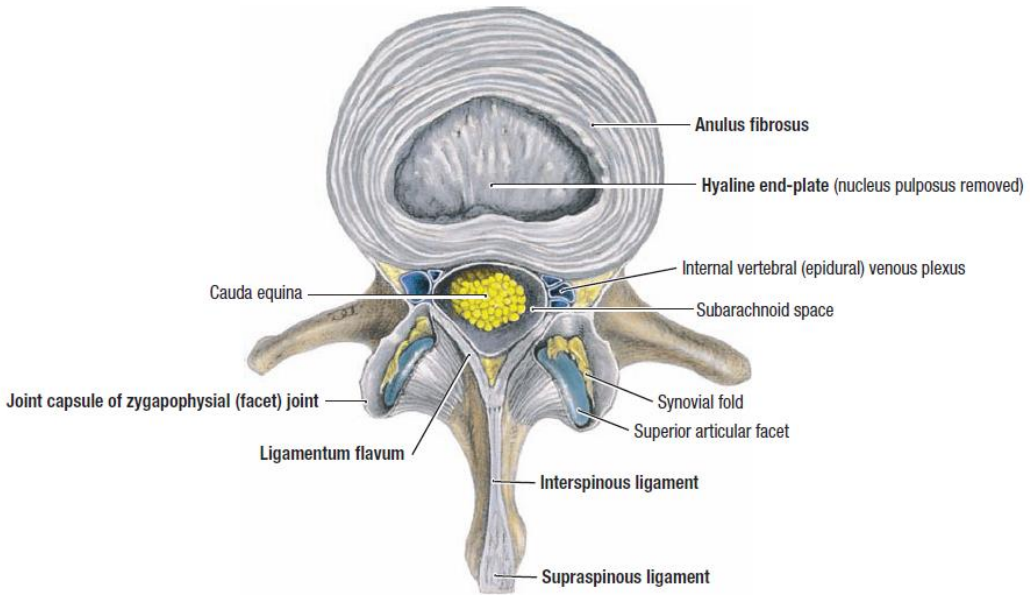
Picture 1: Spinal column lateral view [23]

2.2. Anatomy of ligaments of the spine

Most important ligaments are ligamentum flavum that is connecting lamina, posterior, and anterior longitudinal ligament. These three ligaments keep the vertebrae in alignment, and they allow flexion and extension movement in the spine. Ligamentum flavum are paired ligaments between lamina of adjacement vertebrae. They start from C1-2 superiorly and they end at L5-S1 inferiorly. They cover the anterior and medial

aspect of zygapophyseal joints. Its 5mm thick and is becoming thickest in the lumbar region. This ligament consist of yellow colour elastin that cause it to tighten thats why ligamentum flavum may helps in spine extension.Posterior longitudinal ligament starts from the top of the spinal column specifically from the posterior aspect of the C2 and along the vertebral bodies continues to the bottom inferiorly to sacrum. Posterior longitudinal ligament is thicker in the cervical area than thoracic and lumbar.this ligament is ossifying mostly in cervican region and sometimes in lumbar region too. This might cause compression of spinal cord and it can lead to radicular pain.

The anterior longitudinal ligament is a stronger band and is joining the bodies on the anterior side.Is approximately 3.8mm wide at C1-C2 and increase width from C3-T1. It is strongly attached to vertebral bodies and intervertebral discs. Is more thick in the areas of vertebral bodies and thinner in the areas of intervertebral discs. The function of this ligament is to eliminate extension and is usually injured in cervical region when extension injury occurs. Other ligaments are the intertransverse ligament, supraspinous ligament, interspinous ligament and facet capsulary ligament. Interspinous and supraspinous ligaments are more thickened in the cervical region and form the ligamentum nuchae. [1, 14, 22]



Picture 2: Ligaments and intervertebral disc [23]

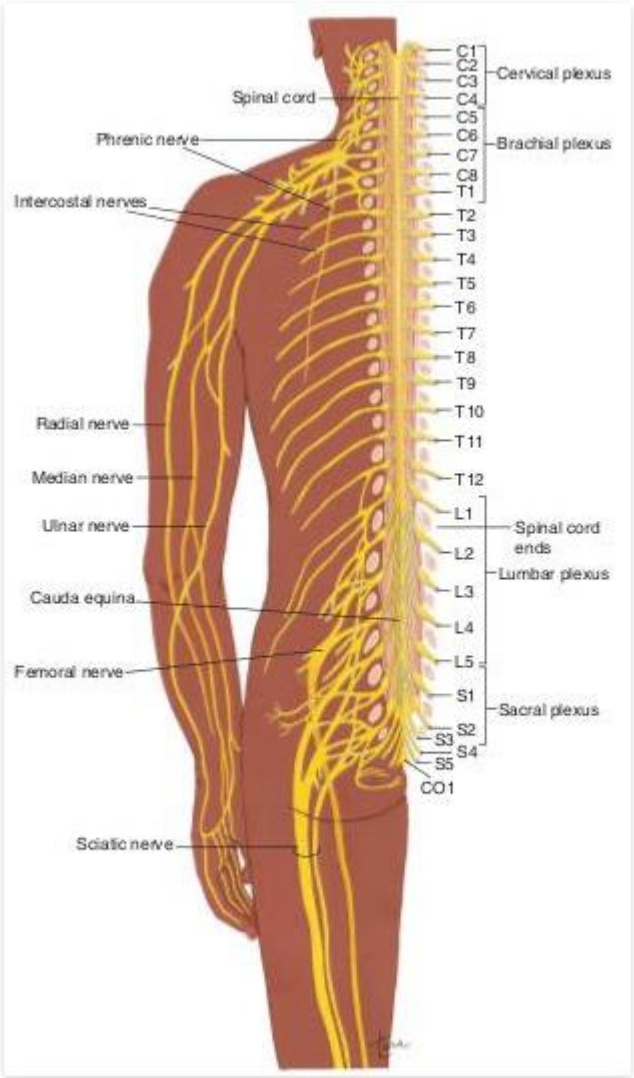
2.3. Joints of lumbar spine

First is the cartilaginous joint (symphysis) which is between two vertebral bodies of the spine. The intervertebral discs form joints between vertebral bodies. Another type is the synovial joint which is between the arches of vertebral bodies.
There are three types of joints in lumbar spine vertebrae. First is the zygapophyseal joints which are known as facet joints they connect the vertebra in the articular process, and they are located in the posterior part of the spine. Is a type of synovial joint and are formed by the articulation of superior articular process of the vertebra with the inferior articular process of the vertebra above it. It allows the spine to bend to the side, forward and backward. Second is the intervertebral joint which is located between each vertebra and is an intervertebral space between them allowing the spine to move. In this space exist the intervertebral disc which absorbs forces that are applying to the spine. The third joint is lumbosacral and sacroiliac joint. Lumbosacral joint is located between the fifth lumbar vertebra and the first sacral segment. The sacroiliac joint is a strong and stable joint and connects the sacral bone with the two pelvic bones. The movement that occurs in sacroiliac joint is very small. [1, 14, 22]

2.4. Spinal nerves and segmental innervations

The vertebral column contains the spinal cord which starts from medulla oblongata from the brainstem and extends to the intervertebral disc between the bodies L1 and L2. The spinal cord is a segmental structure consist of 31 segments, eight cervical (C1-C8), twelve thoracics (T1-T12), five lumbar (L1-L5), five sacral (S1-S5) and one coccygeal (Co1). Each segment is connected to a particular area on the skin (dermatome), skeleton (sclerotome), musculature (myotome) and internal organs (enterotome). The spinal nerves are extending from both sides of the spinal cord, and they are paired. There are 31 pairs of spinal nerves. The first seven spinal nerves exit throught intervertebral foramen above the vertebra of the same number. This pairs of spinal nerves emerge from intervertebral foramina. In cervical and lumbar area spinal cord is enlarged. The cervical region corresponds to C4-T1.In cervical region there are eight cervical spinal nerves and seven cervical vertebrae, thats why the eight cervical nerve exits the intervertebral foramen between C7-Th1. For example if a lesion will occur in C3-C4 disc then the affected nerve is C4, but if a protrusion occur in T3-T4

disc then T3 is the affected nerve. lumbar region corresponds to L1-S3 segments. In this areas, the nerve plexuses innervate the upper and lower limbs. The spinal cord ends at the level of L1-L2 disc and from there sacral and lumbar roots are descending forming the cauda enguina. Lumbar and sacral spinal nerves are connected to the conus medullaris. The spinal nerve divides into a ventral and dorsal ramus. Ventral ramus supplies the muscles and skin from the anterior part of body and dorsal ramus supplies the muscles and skin of posterior part of a body. Ventral and dorsal roots are attached to the spinal cord. The dorsal root consists of the dorsal root ganglion which contains the cell bodies of the primary afferent neurons which are entering the dorsal horn of spinal cord. [1, 14, 22]



Picture 3: Spinal nerves [23]

2.4. Musculature of lumbar spine

Back muscles are important structure for understanding the spine and its function. There are 6 layers of back muscles. First layer it consist of the trapezius and latissimus dorsi muscles.Tapezius muscle is the most superficial and superior back muscle. Latissimus dorsi is most inferior and lateral muscle of the back. Thoracolumbar fascia is also a part of the first layer. Second layer of back muscles are the rhomboid major, rhomboid minor and levator scapulae muscles which lie deep to trapezius muscle and insert in the medial borders of scapula. Third layer consist of two muscles serratus posterior superior and serratus posterior inferior, this muscles help with respiration. Serratus posterior superior helps in inspiration by raising 2-4 ribs. Serratus posterior inferior helps in forced expiration by lower the 9-12 ribs. Fourth layer of muscles include the splenius capitis and splenius cervicis which are the most superficial layer of deep back muscles. The fifth layer is the largest group of back muscles and composed of the erector spinae group muscles. This muscles run throught the length of spine. This group is divided into three subdivisions. Iliocostalis muscles which include iliocostalis lumborum, iliocostalis thoracic and iliocostalis cervicis. Longissimus muscles are also in the erector spinae muscles group and consist of longissimus thorasis, longissimus cervicis and longissimus capitis. The last part of terector spinae muscles group is the spinalis muscles which include spinalis thorasis, spinalis cervicis and spinalis capitis. Finally the sixth layer of back muscles are the deep muscles that course superiorly and medially. It consist of semispinalis muscles, multifidus muscles and rotators muscles.
Lumbar spine includes four groups of muscles because of their position and function.

2.4.1. Extensor muscles of lumbar spine:

Extensors muscles are divided into three layers erector spine which starts from the lumbar region as a single muscle and continues to the upper lumbar region where is divided into vertical columns known as iliocostalis, longissimus, and spinalis. Iliocostalis is the most oblique muscle and spinalis the medial. Another group of extensor muscles is the transversospinal muscle group which is deep in the erector spinae muscle and they act as extensors and also rotators of the lumbar spine. The transversospinal muscle group consists of the muscles semispinalis (thoracic, cervicis, capitis), multifidus and rotators (cervicis, thoracis, lumborum). The deepest layer is the segmental muscles which are divided into two groups, levator costarum but is not

present in the lumbar spine and second the muscles interspinalis and intetransversarii. These muscles are postural stabilizers, and they can increase the efficiency of large muscle group action.

2.4.2. Flexors of lumbar spine:

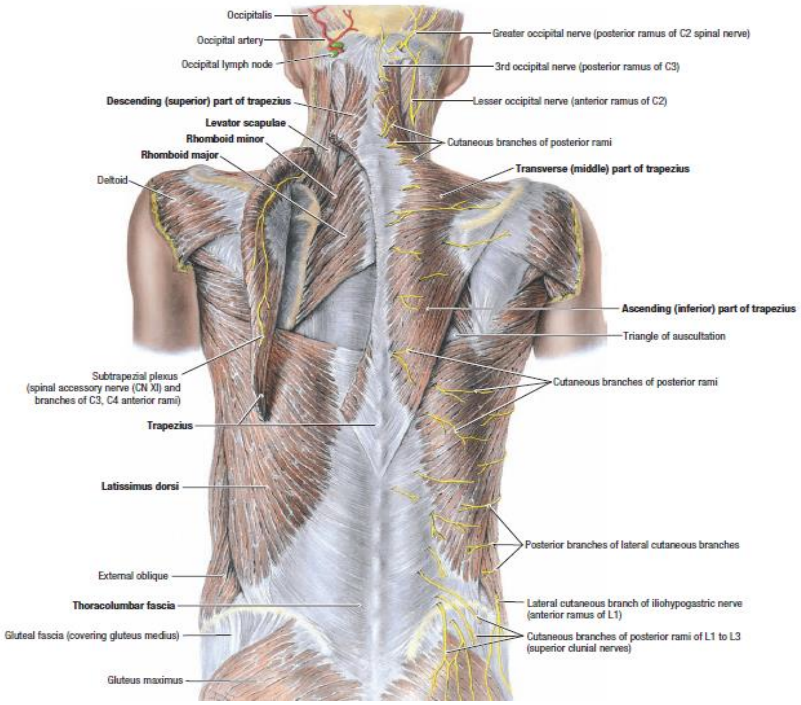
Flexors of the lumbar spine are divided into two groups, the iliothoracic (extrinsic) group, and the femorospinal (intrinsic) group. The iliothoracic group consists of the abdominal wall muscles which are rectus abdominis, external abdominal oblique, internal abdominal obliquus, and transversus abdominis. The femorospinal group consists of the psoas major and iliac muscles.

2.4.3. Lateral Flexors of lumbar spine:

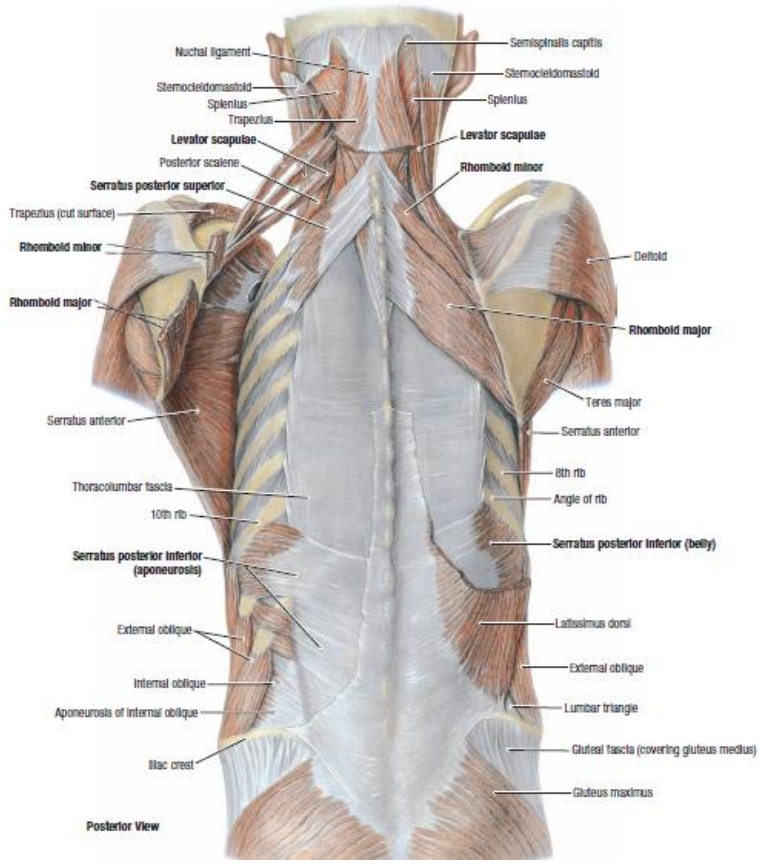
Lateral flexion is a combination of side bending and rotation. Ipsilateral contraction of the oblique, transversus abdominal muscles and quadratus lumborum activate the side bending movement. Also, the bilateral contraction of quadrates lumborum produces the lumbar extension.

2.4.4. Rotators of lumbar spine:

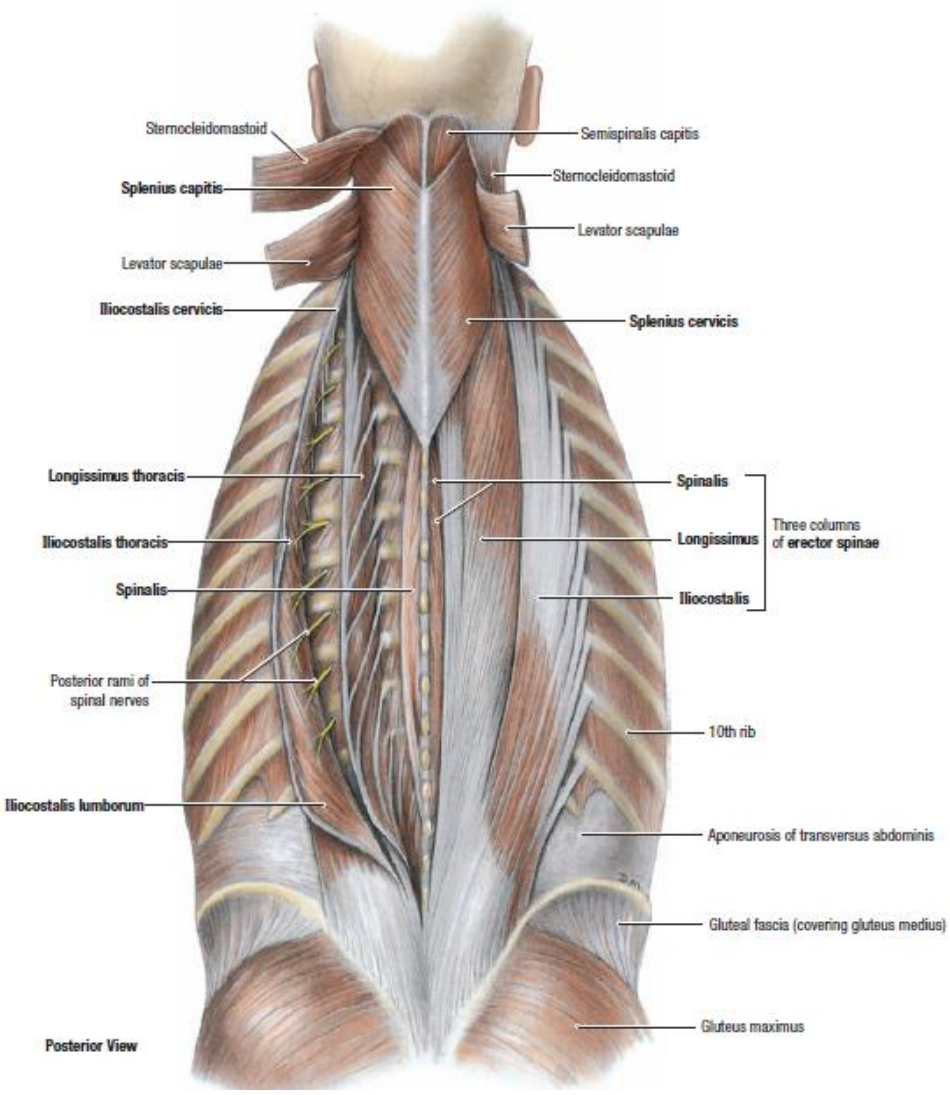
Extensors and lateral flexors assist in a rotation when their primary component has been neutralized by antagonist muscle groups. The transversospinal as a group, they support the extension of the vertebral column, although when they are contracted unilaterally, they cause rotation in the trunk in contralateral direction. Transversospinal muscles are divided into three groups, the semispinalis, multifidus, and rotators lumborum muscles.
[1, 14, 22]



Picture 4: Superficial muscles of the back [23]



Picture 5: Intermediate muscles of back [23]



Picture 6: Deep muscles of the back [23]

2.5. Anatomy of intervertebral disc and its function

The human body has 24 intervertebral discs, and they exist in the space between vertebrae. The importance of intervertebral disc is to separate the vertebral bodies and allows forward movement without the contact of lower edges between the vertebrals. Is also important to be strong so it will not break during movement, and also it can sustain the weight. However is a source of back pain or radicular symptoms when they exert compression on dorsal roots and spinal nerves. Intervertebral disc don't have their vascular system, but they are supplied with nutrients through diffusion from the surrounding tissues. The mechanical efficiency of the annulus fibrosous is load bearing. Is susceptible to tears if subjected to stretching for a long time and it happens, when the surfaces of the two discs are not parallel to each other but at an acute angle to each

other. They give flexibility and allow twisting and bending of the spine. Intervertebral discs protect the spine by absorbing the impact of trauma and body weight. It consists of the annulus fibrosus (a fibrocartilaginous ring) and nucleus pulposus (a gelatinous substance). Intervertebral disc also consist of endplates which cover the top and the bottom of each disc. They are important for proper nutrition of the disc. Vertebral endplates is a cartilage layer 0.6-1mm thick. There are strongly attached to the intervertebral disc but they can easily torn from vertebra body if spinal trauma occur. The annulus fibrosus is the outer part of the disc and consist of collagen fibres that area arranged in between 10 -20 lamellae. Lamellae are the rings which surround the nucleus pulposus and they are getting thicker toward the centre of the disc. It protects nucleus pulposus when forces are applied to the spine and is divided into two regions; the first region is the outer collagenous area and second inner transitional area. Annulus fibrosus also decrease the tension between vertebrae. Nucleus pulposus is the inner part of the intervertebral disc, and 70-90% of nucleus pulposus is water, but it also consists of collagen fibers and non-collagenous proteins. Proteoglycans is also a major component for nucleus pulposus especially decorin and biglycan which interact with collagen, fibronectin and growth factors in matrix and are responsible for homeostasis and repair of the matrix. Nucleus deforms if pressure act on it from any direction and it transmit the applied pressure in all directions.

Annulus fibrosus and nucleus pulposus are similar, they consist of water, proteoglycans and collagen but they differ in the concentration of this components and the type of collagen. Type I collagen is predominance in the annulus fibrosus and type II is predominance in nucleus pulposus. In young age, the tissues can be regenerated when damaged. The cartilaginous tissue can be regenerated in part. The nucleus pulposus, which is losing elasticity and fluidity, becomes brittle through time.

The intervertebral disc degenerates from Hereditary or genetic predisposition (DNA-Gene)

- Age
- Disease
- Traumatic rupture
- Chronic fatigue loading
- Smoking (vasoconstriction disk vessels)

[1, 2, 8, 9, 12, 14, 20, 21, 22]

2.6. Disk herniation

The disk herniation is the mechanical effect of the degeneration of the intervertebral disk and manifests the prolapsed and full disk degeneration in companion with spondylarthritis (a disease where the vertebrae are rubbed together). It's also called ruptured disk or bulging disc. The disc herniation may irritate the meningeal sac causing back pain or the sheath of the nerve root resulting in sciatica. Therefore there is swelling and inflammation. Disk herniation is a very common condition along the spine, especially in lumbar between the 4th and 5th lumbar vertebral bodies, between the 5th lumbar vertebral body and the sacrum and cervical area at the level C5- C6 and C6- C7. It mostly developed when the intervertebral disc pressed between the vertebras, is changing position and protrudes into the spinal canal. What the pain occurred by the disk herniation is associated with the intervertebral level at which the herniation occurs. The pain is typically extended from the back of the buttocks, thighs, and legs, usually on one side.

There are four stages in disk herniation. The first stage is disk degeneration which is the chemical changes that causes disks to weaken. The second stage is prolapsed where the form or position of the disc changes with slight impingement into the spinal canal. The third stage is extrusion in which the nucleus pulposus breaks through annulus fibrosus, but it remains within the disk. The final stage is the sequestration in which the nucleus pulposus breaks through the annulus fibrosus, and it can go outside the intervertebral disk.

Patients most often complain about a backache, stiffness (restriction of movement), pain along the sciatic plexus, aggravation of pain with movements (laughter or coughing), sensory disturbances in the lower extremities, muscular atrophies, often unable to walk, paralyze of extensor muscle group in the leg or calf muscle group.

Most common risk factors for disc herniation are the age because the biochemical changes affect the strength of the disk, the body posture, the lifestyle and of course a trauma on spine. [1, 9, 12, 19, 22]

2.6.1. Diagnosis of disc herniation

Moreover, there are many ways for diagnosing disc herniation. Most common is the Lasegue test, also known as Straight-leg Raising Test. The patient lies down, with knee extended, and the hip flexed. When raising the leg, the nerve roots are stretched,

and it may aggravate sciatica pain in the presence of a disc herniation. If pain occurred, it is an indication that the lower lumbosacral nerve roots are inflamed or compressed.

Another way to diagnose disk herniation is by examining individual muscle groups for strength to determine any signs of weakness. Also, reflexes are tested at the knees and ankles and sensation to pin is tested in both legs.

Also Computed Axial Tomography (CAT) or Magnetic Resonance Imaging (MRI) are used to provide more details about the condition. The MRI is the best method for a physician to see the spinal tissues that cannot be seen in a conventional x-ray and is used to confirm the location of the herniated disc and which nerves are affected. MRI is more sensitive in demonstrating disc degeneration. The detection of disruption in the posterior longitudinal ligament is visible with MRI. Disorders of spinal canal and spinal cord can be viewed with MRI because of its ability to show discs, cereprospinal fluid and cord. However if the patient is unable to get an MRI, CT scan that it shows pressure in spinal cord due to herniated disks, or CT myelography may be performed. CT (computed tomography) is also effective in the valuation of degenerative changes, spondylolysis, trauma, haemorrhage and other conditions. In CT is difficult to evaluate disc disease in thoracic and lower cervical canal. Bones changes can be viewed if spinal trauma occurs. EMG (electromyography) is also another option for diagnosis because it can measure the respond of the nerves how well electrical impulses are moving along nerve tissue. EMG will help in finding the location of the nerve damage. [6, 9, 12]

Picture 7 : MRI slide showing disc protrusion [22]

Disc herniation is divided into 4 states:

Acute - In this state, the patient is relieved in the supine position with the use of analgesics and physiotherapeutic belt when standing up. Patient must avoid active tilting of the pelvis or trunk lifting exercises and positions that increase intervertebral pressure. The sharp pains will disappear progressively within 14 days, but it remains as mild for 3-5 weeks. The patient has to perform the proper exercises for a certain amount of time and has to wear the physiotherapeutic belt for at least three months. If the pain worsens patient has to apply surgical treatment. The orthoses that is used for patients with disc herniation are classified according there rigidity. The aim of corsets, belts or braces is the decreasing of loading, decrease range of motion and correct posture. In acute stage and subacute stage the braces are usefull for pain decreasing. This occur also to patient with radicular pain. Corsets has to worn for3-6 weeks, for decreasing pain,full time at the beginning and then few hours each day.

Subacute - In the subacute form is administered to the patient lumbar belt every time before getting out of bed. Patient has to avoid heavy work and try to keep the spine straight. Also patient has to perform exercises for stimulating abdominal, lumbar and spine muscles.

Chronic - Symptoms are always mild. Because of the rupture of the fibers of the posterior longitudinal ligament and the inflammation chronic sciatica is maintained. Also, the narrowing of the intervertebral disc changes the standard position of the articular surfaces with articular lesions that cause chronic back pain. With physiotherapy, diathermy, sciatica disappears or remains as a mild discomfort. If there is no result, the patient has surgery.

Paralytic - Is occurred when the cauda equina is pressed by large herniated pulposus core, so disturbances created clamps, sexual impotence, sensory disturbances or movement disorders (instability of the lower limbs, reduction or elimination of reflexes).[6,12]

2.6.2. Symptoms

The symptoms of disc herniation differ depending on the position and size of disc herniation. When disc herniation occur there might be compression of nerve roots and that causes burning, tingling and stiffness sensation which radiates to the leg, also

called sciatica. If there is no compression of nerve root patient will not have radiated pain. Patient's pain is more severe during standing, walking or sitting because of the increase loading. Disc herniation affects almost all the structures of body. Muscles will be weak especially when nerve roots are compressed, this will affect the reflexes causing them to decrease. Posture of the patient will change because of the pain. Movement stereotype of patient will be more antalgic so the pain on the affecting extremity will be decreased. These are most common symptoms of patient with disc herniation. [6, 9, 22]

2.6.3. Physical therapy

For physical therapy hot and cold treatments are beneficial. The use of heat is increasing blood flow to the target area and healing the area by delivering extra oxygen and nutrients. Using Cold therapy slows circulation and this help in reducing the inflammation, muscle spasms, and pain. It's usually performed with cold packs and ice massage. There are two types, extreme cryotherapy -180^{o} and mild cryotherapy -20^{o}. Furthermore, transcutaneous electrical nerve stimulation (TENS) is also beneficial. It uses an electrical current to stimulate the muscles. TENS reduces muscle spasms and triggers the release of endorphins, for pain reduction. Diadynamic current which are low frequency and interferential currents which are medium frequency, together with TENS create the analgesic electrotherapy. For patient with low back pain the electrodes are placed transversely on lumbosacral area. If the patient has lumboradicular syndrome then two electrodes are placed on the sides of spinous process at the level of nerve compression and two electrodes are placed longitudinally on lower extremity along the sciatic nerve. Moreover, electrotherapy is used in the acute and chronic form of muscle relaxation and reducing inflammation using pulsed diathermy. Besides the diathermy, we can apply infrared radiation for muscle spasm solution and analgesia. Continuous galvanic current is used to administrate medications by placing the medication on the homologous pole and with the electric field they are entering the body. For patients with low back pain and lumboradicular pain the electrodes should be placed on the sides of lumbar region, longitudinally on lower limb or one electrode placed on the lumbar region and the other on the upper region of thigh.

Ultrasound is also indicated for patient with lumboradicular pain and the duration is 5-10. The treatment is done along the paraspinal muscles or the side of radiated pain. Ultrasound cannot be use in acute stage of pain because it will stimulate the local inflammatory process.If the patient pain is severe, or leg weakness is developing, the doctor may prescribe an epidural steroid injection which is an anti-inflammatory medication. It’s done in the near the affected nerves in the lumbar spine. [6, 9, 15]

2.6.4. Pharmacotherapy

When disc herniation occurs, we can also use drugs for decreasing pain and inflammation, especially non-steroidal anti-inflammatory drugs for example ibuprofen, naproxen, and aspirin. This drugs are better for back pain than radicular pain.they are indicated for patient with acute back pain and with subacute lumboradicular pain. In subacute stage the oral administration is preferred. Acetaminophen it's good painkiller, but it won't reduce the inflammation. Muscle relaxants are useful in case of muscle spasms.There function is to decrease muscle tone and muscle spasm. They are mostly indicated in acute low back pain. Corticosteroids are effective at reducing swelling because of the anti-inflammatory effect and they are used to reduce the radicular inflammatory changes. Usually they are indicated for patient with severe radicular pain in high doses and for patient with moderate severity in low doses. Corticosteroids should not be used if the patient suffers from diabetes, hypertension, gastritis or infectious diseases. Opioids are prescribed only if the pain is severe. Usually when lumboradicular pain occur pure analgesic are recommended, there action is for short duration but they have little to no gastrointestinal side effects. [4, 6, 9, 10]

2.6.5. Physical Examinations

First the evaluation of posture is very important for understanding patient’s problem. For example in acute pain it will be difficult for the patient to stand. In less severe pain there will be flexion of hip and knees and plantar flexion of foot, this is happening in the side of radicular pain. Another clinical signs that are able to view from posture evaluation is the bending trunk and flattening of lumbar region. Usually patient with disc herniation, while sitting they keep the hip extended and try not to bend the lumbar spine to don’t increase the load. Another examination that is useful and most common is the Lasegue’s manuever, the aim of this manuever is to recognise whether

patient has hip pain or radicular pain. For the valuation of the test the patient has to raise the lower limb with extended knee and then the foot is placed on table with flexed hip. This test is positive when sciatic pain exist while foot is raising. If pain will occur while flexing the hip then there is pathologic condition in hip. The pain that occur during the test results from the stretching of nerve roots that are compressed. Knee flexion test (KFT) is also examined, it helps finding not only in the compressed roots in lumbar area but also lumbosacral roots. Flexion in the knee is stretching this roots and pain radiates. Flexion on knee beyond 90^{o} on symptomatic side causes pain in buttock and in the posterior aspect of the thigh. (FNST) Femoral nerve stretch test is important for the examination of patient with disc herniation. This test is evaluated with patient in prone position and flexion of knee. Patient with nerve compression will feel pain when 90^{o} are reached. In addition muscle examination tests are essential for disc herniation. Reducing muscle mass is caused by compression of nerve roots. For example gluteal muscles loss mass when there is impairment of S1 nerve root. Muscle strength is also important for diagnosing nerve compression. Muscles of pelvis girdle and lower limb must be examined. Patellar and ankle reflexes have to be examined too. Patellar reflex depend on L3 and L4 nerve roots. When there is compression of L4 there is impairment in patellar reflex. When L3 nerve root is involvement the reflex is normal or decreased. The ankle reflex depends by S1 nerve root. Reflex will be decreased when nerve root compression occurs. [6, 9, 22]

2.6.6. Physiotherapeutic approach for disc herniation

It's important for a patient suffering from disc herniation to have knowledge of the most valuable information that will help his/her everyday living. For example, the patient must know about the bad lifestyle habits that affect negatively his/her health and also how to manage pain. First of all correcting body posture is very important for the patient. With an ideal alignment, the exercises will be performed correctly. Passive and active movements are beneficial to be carried out within painless limits and without causing any pain. The exercises help eliminate the symptoms of disc herniation and prevention of severeness. Massage is affecting mainly patient with back pain and not in lumboradicular pain, but is useful for decreasing pain. Patient with herniated disc can use massage for 2-3 weeks. If there is pain in buttocks it would be good to extend the massge on the upper part of the buttocks. McKenzie method is efficient for disk herniation. The exercises are effective for the treatment especially in spine flexibility

and pain decreasing. An example of McKenzie method that is usually used is the extension. During extension exercise, the patient is lying in a prone position and uses his/her arms to lift the upper body of the table till the arms are fully extended, or patient reaches the pain threshold. Another useful exercise is the flexion. The patient is in the supine position. The patient brings both knees to the chest and holds this position with his/her hands around the thighs for several minutes. The bending of spine broadens the vertebrae and thus benefit the patient by pain relief. Flexion exercises have the aim to open the intervertebral foramens, mobilize the joints, lengthen the extensor muscles of trunk and strengthen the abdominals. With flexion exercises the intrabdominal pressure is increasing and is important for the stabilization of spine. [4, 5, 7]

2.6.7. Surgical treatment for disc herniation

If there are no results with the physiotherapeutic treatment and the pain constantly increasing, loss of function or leg weakness then surgery is required.

- Epidural Injections for Spinal Pain

An epidural injection is the injection of medication into the epidural space, to provide temporary or prolonged relief from pain or inflammation. The injection may reduce pain and swell in and around the spinal nerve roots. For the injection fluoroscopy or computed tomography (CT or "CAT" scan), are used to make the needle incision easier for the doctor and help him place the needle in the right location.

An epidural injection may also be performed for spinal stenosis, post-operative surgery syndromes such as chronic back or leg pain after spinal surgery and other injuries to spinal nerves, vertebrae, and surrounding tissues.

- Laparoscopic Spine Surgery

Laparoscopy is a surgery done from the front, through the abdomen.
These kinds of operations are used for the more challenging and complex spine problems without having a big incision. The laparoscopic approach uses small incisions instead of long. A lighted telescope is inserted through the incision and is projecting a picture on a screen showing the spine.

- Lumbar microdiscectomy

Microdiscectomy is indicated for patient with herniated disc regardless the type of herniation. Microscope should be used if the doctor is well familiar with it or only during the disc excision. Lumbar microdiscectomy is done to remove the portion of the disc that is affecting the nerve root. It's a small incision about 2-4cm long at the level of interspinous space. When there is a two level disc protrusion the incision should be 5-6cm long. After the incision cauterization is done on the dermal vessels. Subcutaneous fat is separated from the fascias and then thoracolumbar fascia is sectioned in semicircle from midline. The muscles are separated from the deep aspect of latter. First, the erector spine is removed from the bony arch. Then the doctor can access the nerve roots by removing the membrane ligamentum flavum. After a portion of the inside of facet joint is removed to have access to the nerve root. Then only the herniated part of the disk material is removed from under the nerve root. During the microdiscectomy operative microscope is used to provide light vertical beam which gives excellent lighting regardless the depth of structures. The patient feels relieved immediately after the microdiscectomy.After a microdiscectomy, the patient has a limitation to movements. For example bending, lifting, or twisting for six weeks to prevent a recurrent lumbar disc herniation. The healing may take three to four months to scar over. Like in every other surgery microdiscectomy has risks and sometimes complications. Dural tear (cerebrospinal fluid leak) in which post-operatively the patient is asked to lay for one to two days for the reducing of the leaking, nerve root damage, bowel/bladder incontinence, bleeding, and infection. Of course, these complications are rare.
[15, 16, 17, 18]

2.6.8. Etiology and etiopathogenesis

Disc herniation's can be asymptomatic, and most of the intervertebral disc herniations recover within six months. Lumbar disc herniation's of L4-L5 and L5-S1 discs are most commonly affected. The cervical disc herniations are most located at level C5-C6 and C6-C7. Often, in disc herniation, the direction that occurs is in the posterolateral direction, because annulus fibrosis is thinner and not supported by the anterior and posterior longitudinal ligament. Disc herniation occurred when there is presence of compression and hyperflexion. Nucleus pulposus absorp water and realease it to balance this loads, while endplates diffuse nutrition into the nucleus. Nucleus

pulposus, annulus fibrosus and endplates allow the mobility of vertebrals. When disc degeneration occur the endplates are not able to diffuse nutriens into nucleus and the number of proteoglycans is decreased and that’s result in the weak annular support. The hydration of nucleus pulposus is very important for the stress concentration. When the nuclear pressure decreased, the loading is acting on annulus fibrosus and increase the risk of stress concentration. [9]

3. Special Part - Case Study

3.1. Methodology

The clinical work practice was done in Ustřední vojenská nemocnice in Prague. The therapy sessions started on 11.1.2016 and finished on 14.1.2016.

I had 4 days of practice with my patient because she was released from hospital. My clinical work placement was supervised by Mgr. Barbora Grmanova and it had the total amount of 80 hours. i mostly used manual therapy. For the examinations i used Buck hammer, goniometer and plumb line.

My work has been approved by the Ethics Comittee of the Faculty of Physical Education and Sport at Charles University.

3.2 Anamnesis:

Name of the patient: S.V

Year of birth: 17.4.1984

Sex: Female

Diagnosis: Microdisectomy of L4/5.

Code: M511

3.2.1. Present State:

11.1.2016.

Today was the 3rd day after the surgery. The patient didn't complain about pain, but she was feeling a slight stiffness around the area of the surgery. There was no pain propagated to the lower extremity.

Weight: 85Kg

Height: 180cm

BMI: 26,2

BP: 113/78

BPM: 78

3.2.2. Chief complaint:

Before the surgery patient had radicular pain in left thigh and her lower back (level of pain 7/10). After the surgery the pain is diminished, almost inexistent. The problem that patient has is tightness in lumbar area and the slight pain around and on the scar.

3.2.4. History of present problem:

The patient has pain of lower back for 6 years, the pain irradiate on her left thigh L4/L5 dermatome. She had MRI on 8.11.2015 and she diagnosed with disk herniation on L4-L5. The doctor decided to undergo microdisectomy surgery of L4-L5 with decompression of L5. After the surgery the pain was about 4-5 on the visual analog scale (VAS), and is located around the operated area.

3.2.5. Pharmacological anamnesis:

Patient is having only painkillers after the microdiscectomy.

3.2.6. Abuses:

None

3.2.7. Allergies:

None

3.2.8. Social anamnesis:

The patient lives with her parents in a house and uses stairs.

3.2.9. Gynecological anamnesis:

No problems

3.2.10. Occupational anamnesis:

She works in office for economics.

3.2.11. ADL:

The patient after the surgery she can walk well. She is independent and she can go to toilet alone, dress herself and groom. Before the operation the patient was also independent but she was performing the activities with sharp pain on lower back and left leg.

3.2.12. Surgical anamnesis:

8.1.2016 Microdisectomy of L4/5 and decompression of L5 on left side.

3.2.13. Family anamnesis:

Her mother has Diabetes

3.2.14. Hobbies:

She plays badminton 2 times a week; she is skiing and she also bicycling almost every day.

3.2.15. Prior rehabilitation:

During the 6 years she had electro therapy, magneto therapy 10 times and massages therapy 3 times. She wasn’t feeling better after the therapies.

3.2.16. Excerpt from patient's healthcare file:

The MRI was done on 8.11.2015. The MRI showed degenerative changes of intervertebral disk of L4-L5. The intervertebral disk was herniated and compressing towards the left side.

3.2.17. Indication for rehabilitation:

The indication was recommended by my supervisor
Educate the patient about transfer and verticalization.
Exercises on bed for prevent thromboembolism.
Correct any possible muscle imbalances.
Activation of deep stabilization system.

3.2.18. Differential balance:

Because of patient's work, long period of sitting might cause the progression of the disk herniation. According to patient's anamnesis and condition we expect that muscles of lumbar area will be weak that's why weakness in deep stabilization system will occur and patient will have problem during standing position because she will be unstable. The pain that the patient has could be from the scar and the restricted connective tissue around it. Restrictions between the connective tissues, fascia and muscles can cause muscle imbalance. Moreover muscles around the operated area and the whole L/S region would be weekend because of patient immobility due to the surgery and also due to the fear of pain. I also expect that range of motion in hip, knee and ankle will be restricted especially in left side. After the operation patient will use more kyphotic posture and slow walking. The movement pattern will be antalgic to reduce any loading on the affected extremity. Of course this will affect the active daily living of patient, cause the patient to eliminate some of the activities that used to do. Finally all the changes after the surgery will affect the breathing pattern especially muscle imbalance and kyphotic posture.

3.3. Initial Kinesiological Examination:

11.2.2016 1st day of therapy

3.3.1. Observation

The patient is independent; she can walk alone but slow. There are limitations of range of movements of lower extremities.

3.3.2. Postural Examination (plumb line test)

Anterior view:

Normal base of support
Ankle joint is slightly in external rotation in both sides
Patellae are in the same level
No varosity or valgosity in knee joints
Pelvis iliac crests are in alignment
Umbilicus is in the midline
Left thoracolumbar triangle is smaller
Left shoulder is higher
Head is in midline

Lateral view (right side):

Ankle joints in both sides are in external rotation
Knees in both sides are in good alignment there is no hyperextension
Pelvis is in good alignment, there is no anteversion or retroversion
Lumbar spine is in good alignment
Thoracic spine is slightly kyphotic
Cervical spine is in good alingment
Slight protraction of shoulders
Head is shifted forward

Lateral view (left side):

Ankle joints in both sides are in external rotation
Knees in both sides are in good alignment there is no hyperextension
Pelvis is in good alignment, there is no anteversion or retroversion
Lumbar spine is in good alignment
Thoracic spine is slightly kyphotic
Cervical spine is in good alingment
Slight protraction of shoulders
Head is shifted forward

Posterior view:

Normal base of support
Slight external rotation of both feet
No varosity or valgosity in knee joints
Popliteal lines are symmetrical
Gluteal lines are aligned
Pelvis is physiological without elevation
Spine is in good alignment there is no C curve or lateral bending
Head is positioned in midline

3.3.3. Dynamic Spine Tests

Extension:
The movement was performed without pain.
Restriction of movement especially in lumbar region.
Bigger movement occurred in thoraco-lumbar region.

Lateral flexion:
The movement was performed without pain.
The movement was restricted in both sides.
The spinal curvatures were symmetrical.
The bigger movement was noticed in thoracic region.

3.3.4. Pelvic examination

Anterior iliac spines are on the same level.

Posterior iliac spines are on the same level.

Iliac crests are in alignment.

According the examination patient pelvis is not in retroflexion neither in anteflexion but it is in normal alignment.

3.3.5. Gait Examination

The patient was walking slowly without any pain. She reaches the floor with the heels first in both feet.

Her steps were short and symmetrical.

Her trunk was stiff, no big movement occured in her trunk during walking.

She had very slight movement in pelvis during walking. Pelvis was rotating in both sides slightly.

She had bigger swinging movement of her left hand.

Backward walking (Gluteals): The walking was performed with bigger movements in hands and bigger rotation in trunk.

Walking on heels (L5): She was able to perform it without pain.

Walking in tiptoes (S1): She was able to perform it without any difficulty or pain.

Walking with bend knees (L4): The patient had slight difficulty performing this modification of gait. She didn't have any pain during the examination but it was difficult for her to keep her balance.

3.3.6. Anthropometric Measurement

	Right Lower Extremity	Left Lower Extremity
Anatomical length	95cm	95cm
Functional length	100cm	100cm
Thigh circumference	53cm	49,5cm
Knee circumference	39cm	37,5cm
Calf circumference	35,5cm	34,5cm
Ankle circumference	25cm	25,5cm
Metatarsals circumference	21,5cm	22cm

Table 1: Anthropometric Measurements

3.3.7. Special Tests

Weight bearing test: Right-45Kg, Left-40Kg

Romberg test: Romberg test I , II and III negative.

Tredelenburg test: Negative for both sides.

Vele's test: Negative

3.3.8. Range of motion examination, according Kendall

For the examination I used plastic goniometer

	Right Lower Extremity		Left Lower Extremity	
Movement	Active	Passive	Active	Passive
Hip extension	10^0	10^0	10^0	10^0
Hip flexion	85^0	90^0	80^0	85^0
Hip abduction	35^0	40^0	35^0	40^0
Hip adduction	10^0	10^0	10^0	10^0
Hip external rotation	40^0	45^0	40^0	45^0
Hip internal rotation	35^0	40^0	35^0	40^0
Knee flexion	120^0	125^0	120^0	125^0
Knee extension	0^0	0^0	0^0	0^0
Ankle plantar flexion	35^0	40^0	35^0	40^0
Ankle dorsal flexion	15^0	15^0	15^0	15^0
Ankle inversion	30^0	40^0	30^0	35^0
Ankle eversion	15^0	20^0	10^0	15^0

Table 2: Range of motion examination

3.3.9. Muscle Length Examination, according Janda

Muscles	Right Lower Extremity	Left Lower Extremity
Iliopsoas	0	0
Hamstrings	1	1
Quadriceps	0	0
Gastrocnemius	0	0
Soleus	0	0

Table 3: Muscle Length Examination (Grade 0: no shortness was found)

3.3.10. Muscle Strength Examination, according Kendall

	Right Lower Extremity	Left Lower Extremity
Hamstrings	4^{+}	4^{+}
Quadriceps	4^{+}	4^{+}
Iliopsoas	4^{+}	4^{+}
Tensor fascia latae	4	4
Gluteus minimus	4	4
Gluteus medius	4	4
Gluteus maximus	4	4
Piriformis	4^{-}	4^{-}
Quadratus lumborum	4	4
Gastrocnemius	5	5
Soleus	5	5
Tibialis anterior	4^{+}	4^{+}
Peronius longus	4^{+}	4^{+}
Extensor hallucis longus	4	4
Flexor hallucis longus	5	5
Flexor hallucis brevis	5	5
Plantar interossei	5	5
Dorsal interossei	5	5
Rectus abdominis	3	

Table 4: Muscle Strength Examination

3.3.11. Palpation Examination

	Right side			Left side		
Muscles	Pain	Tonus	TrPs	Pain	Tonus	TrPs
Hamstrings	No	Normal	No	No	Normal	No
Quadriceps	No	Normal	No	No	Normal	No
Tensor fascia latae	No	Normal	No	No	Normal	No
Gluteus medius	No	Normal	No	No	Normal	No
Gluteus maximus	No	Hypotonic	No	No	Hypotonic	No
Iliopsoas	Slight	Normal	No	Slight	Normal	No
Piriformis	Yes	Hypertonic	No	Yes	Hypertonic	No
Gastrocnemius	No	Normal	No	No	Normal	No
Soleus	No	Normal	No	No	Normal	No
Tibialis anterior	No	Normal	No	No	Normal	No
Rectus abdominis	No	Hypotonic	No	No	Hypotonic	No
Quadratus lumborum	Slight	Normal	No	Slight	Normal	No

Table 5: Palpation Examination

3.3.12. Joint Play Examination, according Lewit

Joints	Directions	Right side	Left side
Thoracic spine	Flexion Extension Side-bending Rotation	Unblocked	Unblocked
Cervical spine	Flexion Extension Side-bending Rotation	Unblocked	Unblocked

Sacroiliac joint	Springing test Stoddard	Unblocked	Unblocked
Head of fibula	Dorsal Ventral	Unblocked Unblocked	Unblocked Unblocked
Tibiofibular joint	Internal rotation External rotation	Unblocked Unblocked	Unblocked Unblocked
Patella	Cranial Caudal Lateral Medial	Unblocked	Unblocked
Lisfranc	Plantar Dorsal	Unblocked	Unblocked
Talocrural	Dorsal	Unblocked	Unblocked

Table 6: Joint Play Examination

3.3.13. Neurologic Examination

I provided neurologic examination with the use of Buck Hammer.

Superficial sensation in dermatomes:

L1, L2, L3, L4, L5, S1, S2

Patient was able to feel my touch in all dermatomes and she had the same sensation in both legs.

Deep sensation:

Position sense: Heel along tibia, the patient was able to perform it in both sides.

Patellar reflex (L2-L4):

Present in both sides. Normal response (2^{+})

Achilles tendon reflex (S1):

Present in both sides. Normal response (2^{+})

3.3.14. Soft Tissue Examination, according Lewit

I couldn't examine the patient's scar because of the stitches and the bandages.

The mobility of skin, sub-skin and fascias (Th12-S1) on the lumbar area are slightly restricted in caudal direction.

The mobility of skin, sub-skin and fascias on thoracic and cervical area are normal.

3.3.15. Movement Pattern Evaluation, according Janda

Hip extension: Patient performed the movement pattern very well. The activation sequence of the muscles was correct in both sides.

Hip abduction: There was good activation of gluteus medius and minimus. The movement was pure abduction without any flexion of hip joint.

3.3.16. Examination of breathing pattern:

Patient when is in rest uses abdominal breathing.
During inhalation and exhalation there were no restrictions of the lower ribs.

3.3.17. Initial Examination Conclusion:

According the anamnesis, patient has a slight stiffness and pain in lumbar area specifically around and on the scar. The plumb line examination showed that both ankles are in external rotation and left thoracobrachial triangle is smaller. In addition there is slight protraction of shoulders and head is shifted forward, in my opinion this is a result of prolonged fault sitting position. Moreover the dynamic spine evaluation showed that there were restrictions especially in lumbar spine during extension and lateral flexion. The patient's gait was good but she had difficulties in evaluating the gait with bend knees because she couldn't balance.this might cause from the weakening of muscles and also fear of patient toward pain. Also there were some slight differences in knees and thighs circumference, the right leg had bigger circumference. According muscle strength test and palpation examination rectus abdominis is weak and hypotonic, piriformis is hypertonic and gluteus maximus hypotonic. The soft tissue evaluation showed that the fascia in lumbar area is restricted in caudal direction. Finally the neurological examinations are normal.

3.4. Short-term and long-term rehabilitation plan

3.4.1. Short-term rehabilitation plan

- Prevention of thromboembolism.
- Treatment of scar and soft tissues around.
- Training of walking pattern.
- Increase ROM in flexion, rotation and abduction of hip joint.
- Strengthening of weakened abdominal muscles.

- Lengthen short muscles.
- Soft tissue techniques for releasing the fascia in lumbar area.
- Relaxation of hypertonic muscle (piriformis).

3.4.2. Long Rehabilitation Plan

- Treatment of the scar and soft tissues around.
- Exercises to maintaining the muscle strength and ROM.
- Improve patient balance.
- Able to return to her ADL activities and hobbies.
- Educate the patient for self-therapeutic techniques to exercise after she goes home.

3.5. Therapy Proposal

- Scar therapy when the bandages will be removed.
- Release tension from lumbar fascia, by soft tissue techniques.
- Breathing exercises for activation of abdominal muscles.
- Active exercises in flexion and abduction in hip joint while lying and later in standing position for increasing ROM.
- PIR techniques for releasing tension in piriformis muscle.
- Strengthening of abdominal muscles and whole deep stabilization system.

3.6. Therapy progress

Session 1

Date: 11.01.2016

Subjective: Patient has no pain but she feels a stiffness in her lower back.

Objective: Restrictions in soft tissue in lumbar area in caudal direction especially around the scar. Limitation in ROM of hip in flexion , abduction and rotation. The Rom of hip flexion is 85^{o}, hip abduction 35^{o}, hip external rotation 40^{o}, hip internal rotation 35^{o}. Piriformis muscle was hypertonic in both sides. Rectus abdominis and gluteus maximus were hypotonic. Hamstrings were shorten.

Goals of today's therapy:

- Prevent thromboembolism.
- Release tension from soft tissues.
- Relaxation of hypertonic muscles.
- Strengthen weak muscles.
- Lengthen shorten muscles.

Therapy applied:

- For thromboembolic prevention patient performed exercises in dorsal flexion, plantar flexion and circular movements of ankles in both sides.
- Soft tissue techniques, according Lewit on skin, sub skin and fascia on lumbar area in cranial and caudal direction on the area of Th12-S1.
- Isometric contraction of quadriceps while dorsal flexing ankle and extending knee joint.
- Active and passive movements in flexion, extension, abduction and adduction of hip for increase ROM. Repetition 6 times.
- Breathing exercises for activation of diaphragm and abdominal muscles. Patient is in supine position and I ask her while breathing out to contract abdominal muscles.
- PIR, according Lewit for piriformis relaxation in both sides.
- Squat exercise until 90^{0} of flexion in hip joint, patient is holding on a metal bar that is attached on the wall. This exercise was already done by the patient according the supervisor's assistance.Repetition 6 times.

- Standing on toes and heels exercise. Repetition 6 times.
- Standing on one leg exercise. Repetition 6 times.
- In supine position I provided for the patient passive stretching for hamstrings for both sides.

Subjective results: The patient after the therapy she was feeling relaxed without any pain and less stiff in the lumbar area.

Objective results: After the soft tissue technique on lumbar area the fascia around the scar was movable and the restriction was released. The muscle strength of the patient is normal due to the sports she does, but still there is weakness in abdominal muscles. Hamstrings length was improved.

Self-therapy: I ask my patient to provide by herself the active movements, breathing exercise, isometric contraction for quadriceps and the exercises for thromboembolic prevention.

Session 2
Date: 12.01.2016

Subjective: Patient didn't have any pain but she was feeling slight stiffness in lumbar area.

Objective: Piriformis muscle was hypertonic in both sides.

Goals of today's therapy:

- Release tension from soft tissues.
- Relaxation of hypertonic muscle.
- Strengthen weak muscles.
- Show my patient new exercise unit.

Therapy applied:

- For thromboembolic prevention patient performed exercises in dorsal flexion, plantar flexion and circular movements of ankles in both sides.

- Soft tissue techniques, according Lewit on skin, sub skin and fascia on lumbar area in cranial and caudal direction in the area of Th12-S1
- Isometric contraction of quadriceps while dorsal flexing ankle and extending knee joint.
- Active and passive movements in flexion, extension, abduction and adduction of hip for increase ROM.Repetition 7 times.
- Breathing exercises for activation of diaphragm and abdominal muscles. Patient is in supine position and I ask her while breathing out to contract abdominal muscles.
- PIR, according Lewit for piriformis relaxation for both sides.
- Squat exercise until 90^0 of flexion in hip joint, patient is holding on a metal bar that is attached on the wall. This exercise was already done by the patient according the supervisor's assistance. Repetition 7 times.
- Standing on toes and heels exercise. Repetition 7 times.
- Standing on one leg exercise. Repetition 7 times.
- In supine position I provided for the patient passive stretching for hamstrings for both sides.
- Today's new exercise – patient was kneeling on bed with 90^o flexion in hip and knee joint and 90^o in shoulder joint. I asked from patient to elevate right hand and hold it for 5s. Then I asked her to do the same with right hand, left leg and right leg. Elevated extremity had to be in the level of the spine. The goal of this exercise is to train the extensor muscles and activate the abdominal muscles to control and maintain the neutral spine posture. Repetition 6 times.

Subjective results: My patient after the exercises she felt relaxed and without stiffness on her lower back.

Objective results: There was release in the soft tissues of lower back. Length of hamstrings was improved also the range of motion in hip flexion.

Self-therapy: I ask my patient to provide by herself the active movements, breathing exercise, isometric contraction for quadriceps ,the exercises for thromboembolic prevention and the new exercise I showed her.

Session 3

Date: 13.01.2016

Subjective: Today the patient feels better. She doesn't feel the stiffness anymore around the scar.

Objective: There was increasing in hip range of motion. Hip flexion was increased for 5^{o}. I could also feel that the rectus abdominis is still hypotonic. In addition hamstrings's length is increasing.

Goals of today's therapy:

- Release tension from soft tissues.
- Relaxation of hypertonic muscle.
- Strengthen weak muscles.
- Training of correct walking pattern.
- Show my patient new exercise unit.

Therapy applied:

- For thromboembolic prevention patient performed exercises in dorsal flexion, plantar flexion and circular movements of ankles in both sides.
- Soft tissue techniques, according Lewit on skin, sub skin and fascia on lumbar area in cranial and caudal direction in the area of Th12-S1.
- Isometric contraction of quadriceps while dorsal flexing ankle and extending knee joint.
- Active and passive movements in flexion, extension, abduction and adduction of hip for increase ROM. Repetition 8 times.
- Breathing exercises for activation of diaphragm and abdominal muscles. Patient is in supine position and I ask her while breathing out to contract abdominal muscles.
- PIR, according Lewit for piriformis relaxation in both sides.
- Squat exercise until 90^{0} of flexion in hip joint, patient is holding on a metal bar that is attached on the wall. This exercise was already done by the patient according the supervisor's assistance. Repetition 8 times.
- Standing on toes and heels exercise. Repetition 8 times.

- Standing on one leg exercise. Repetition 8 times.
- In supine position I provided for the patient passive stretching for hamstrings for both sides.
- Patient was kneeling on bed with 90^{o} flexion in hip and knee joint and 90^{o} in shoulder joint. I asked from patient to elevate right hand and hold it for 8s. Then I asked her to do the same with right hand, left leg and right leg. Elevated extremity had to be in the level of the spine. Repetition 6 times.
- Today's new exercise – bridging, patient was laying supine with bending knees and she was pushing off the bed to raise her pelvis. The goal of this exercise is the strengthening of spinal muscles, hamstrings and gluteus and also to improve core stability.
- Today's new goal is to teach patient the correct walking pattern. yes

Subjective results: My patient today after the therapy was feeling good. She didn't have any pain. Also she was providing all the exercises with more confidence.

Objective results: According some examinations I performed the range of motion in hip is increased, abdominal muscles are stronger. The tissue around the scar is movable. Also the hamstring length is better than the first examination.

Self-therapy: Today's self-therapy is the active movements, breathing exercise, the exercises for thromboembolic prevention and the new bridging exercise I showed her.

Session 4
Date: 14.01.2016

Subjective: Today patient is feeling relaxed. She doesn't have any pain and she was in good mood.

Objective: Lower part of Rectus abdominis is hypotonic. Soft tissue and fascia around the scar is movable and patient doesn't feel the stiffness as before. Hamstrings length is increasing. Gluteus maximus is weak.

Goals of today's therapy:

- Release tension from soft tissues.
- Relaxation of hypertonic muscle.
- Strengthen weak muscles.
- Because today is the last session with my patient I showed her again all the exercises, correct walking and I explain to her contraindicated movements so she will avoid them.

Therapy applied:

- Exercises in dorsal flexion, plantar flexion and circular movements of ankles in both sides.
- Soft tissue techniques, according Lewit on skin, sub skin and fascia on lumbar area in cranial and caudal direction in the area of Th12-S1.
- Isometric contraction of quadriceps while dorsal flexing ankle and extending knee joint.
- Active and passive movements in flexion, extension, abduction and adduction of hip for increase ROM. Repetition 10 times.
- Breathing exercises for activation of diaphragm and abdominal muscles. Patient is in supine position and I ask her while breathing out to contract abdominal muscles.
- PIR, according Lewit for piriformis relaxation for both sides.
- Squat exercise until 90^0 of flexion in hip joint, patient is holding on a metal bar that is attached on the wall. This exercise was already done by the patient according the supervisor's assistance. Repetition 10 times.
- Standing on toes and heels exercise. Repetition 10 times.
- Standing on one leg exercise. Repetition 10 times.
- In supine position I provided for the patient passive stretching for hamstrings for both sides.
- Patient was kneeling on bed with 90^o flexion in hip and knee joint and 90^o in shoulder joint. I asked from patient to elevate right hand and hold it for 10s. Then I asked her to do the same with right hand, left leg and right leg. Elevated extremity had to be in the level of the spine. Repetition 10 times.

- Bridging - patient was lying supine with bending knees and she was pushing off the bed to raise her pelvis. Repetition 10 times.
- Reeducation of correct walking pattern.

Subjective results: After and during the exercises patient didn't feel any pain. She was very energizing.

Objective results: Today after a brief examination range of motion in hip was increased, hamstrings length is better, restrictions of fascia around scar is released. Although rectus abdominis and gluteus maximus still need more exercises to achieve the appropriate result.

Session 5: (Theoritical)

This part is theoretical because my patient was released from hospital.
Goals of the therapy:

- If the stitches are removed I will provide therapy for the scar
- Release of the soft tissues in lumbar area
- Strengthen weak muscles
- Relaxation of hypertonic muscles
- Breathing exercises
- Improve flexion, extension and lateral flexion of spine.

Therapy applied:

- Exercises in dorsal flexion, plantar flexion and circular movements of ankles in both sides.
- Soft tissue techniques, according Lewit on skin, sub skin and fascia on lumbar area in cranial and caudal direction in the area of Th12-S1.
- Isometric contraction of quadriceps while dorsal flexing ankle and extending knee joint. Repetition 10 times.
- Active and passive movements in flexion, extension, abduction and adduction of hip for increase ROM. Repetition 10 times.
- Breathing exercises for activation of diaphragm and abdominal muscles. Patient is in supine position and I ask her while breathing out to contract abdominal muscles.

- PIR, according Lewit for piriformis relaxation in both sides.
- Squat exercise until 90^0 of flexion in hip joint, patient is holding on a metal bar that is attached on the wall. Repetition 10 times.
- Standing on toes and heels exercise. Repetition 10 times.
- Standing on one leg exercise. Repetition 10 times.
- In supine position I provided for the patient passive stretching for hamstrings for both sides.
- Patient was kneeling on bed with 90^o flexion in hip and knee joint and 90^o in shoulder joint. I asked from patient to elevate right hand and hold it for 10s. Then I asked her to do the same with right hand, left leg and right leg. Elevated extremity had to be in the level of the spine. Repetition 10 times.
- Bridging - patient was lying supine with bending knees and she was pushing off the bed to raise her pelvis. Repetition 10 times.
- Soft tissue techniques on the scar - S-wave on the scar , C-wave on the scar ,hold and release on the scar, deep pressure applied on the scar,
- Exercise to improve the mobility of the spine in flexion, extension and lateroflexion. Patient is asked to be on all fours, with the whole spine in line with the head. Patient is slowly flexing her head to her cervical spine to her thoracic and then the lumbar spine. For lateroflexion, the patient is asked to look at her right heel by maintaining the straight position of the spine and by looking at her left heel. Finally for extension, patient is extending slowly her head back, extend her cervical spine to her thoracic and then the lumbar spine. The goal of this exercise is to increase mobility of the whole spine. Repetition 10 times.

Session 6: (Theoritical)

Goals of the therapy:

- If the stitches are removed I will provide therapy for the scar
- Release of the soft tissues in lumbar area
- Strengthen weak muscles
- Relaxation of hypertonic muscles
- Breathing exercises
- Improve flexion, extension and lateral flexion
- Improve balance

Therapy applied:

- Exercises in dorsal flexion, plantar flexion and circular movements of ankles in both sides.
- Soft tissue techniques, according Lewit on skin, sub skin and fascia on lumbar area in cranial and caudal direction in the area of Th12-S1.
- Isometric contraction of quadriceps while dorsal flexing ankle and extending knee joint. Repetition 12 times.
- Active and passive movements in flexion, extension, abduction and adduction of hip for increase ROM. Repetition 12 times.
- Breathing exercises for activation of diaphragm and abdominal muscles. Patient is in supine position and I ask her while breathing out to contract abdominal muscles.
- PIR, according Lewit for piriformis relaxation for both sides.
- Squat exercise until 90^0 of flexion in hip joint, patient is holding on a metal bar that is attached on the wall. Repetition 12 times.
- Standing on toes and heels exercise. Repetition 12 times.
- Standing on one leg exercise. Repetition 12 times.
- In supine position I provided for the patient passive stretching for hamstrings for both sides.
- Patient was kneeling on bed with 90^o flexion in hip and knee joint and 90^o in shoulder joint. I asked from patient to elevate right hand and hold it for 10s. Then I asked her to do the same with right hand, left leg and right leg. Elevated extremity had to be in the level of the spine. Repetition 12 times.
- Bridging - patient was lying supine with bending knees and she was pushing off the bed to raise her pelvis. Repetition 12 times.
- Soft tissue techniques on the scar - S-wave on the scar , C-wave on the scar ,hold and release on the scar, applied deep pressure on the scar
- Exercise to improve the mobility of the spine in flexion, extension and lateroflexion. Patient is asked to be on all fours, with the whole spine in line with the head. Patient is slowly flexing her head to her cervical spine to her thoracic and then the lumbar spine. For lateroflexion, the patient is asked to look at her right heel by maintaining the straight position of the spine and by looking at her left heel. Finally for extension, patient is extending slowly her head back,

extend her cervical spine to her thoracic and then the lumbar spine. Repetition 12 times.

- For improving the balance of patient I will let her walk slowly on a soft physiotherapeutic mattress without shoes.

Session 7: (Theoritical)

Goals of the therapy:

- Release of the soft tissues in lumbar area
- Strengthen weak muscles
- Relaxation of hypertonic muscles
- Breathing exercises
- Improve flexion, extension and lateral flexion
- Improve balance
- Give advice for the patient for avoiding bending and twisting in daily activities.

Therapy applied:

- Exercises in dorsal flexion, plantar flexion and circular movements of ankles in both sides.
- Soft tissue techniques, according Lewit on skin, sub skin and fascia on lumbar area in cranial and caudal direction in the area of Th12-S1.
- Isometric contraction of quadriceps while dorsal flexing ankle and extending knee joint. Repetition 12 times.
- Active and passive movements in flexion, extension, abduction and adduction of hip for increase ROM. Repetition 12 times.
- Breathing exercises for activation of diaphragm and abdominal muscles. Patient is in supine position and I ask her while breathing out to contract abdominal muscles.
- PIR, according Lewit for piriformis relaxation for both sides.
- Squat exercise until 90^0 of flexion in hip joint, patient is holding on a metal bar that is attached on the wall. Repetition 12 times.
- Standing on toes and heels exercise. Repetition 12 times.
- Standing on one leg exercise. Repetition 12 times.

- In supine position I provided for the patient passive stretching for hamstrings for both sides.
- Patient was kneeling on bed with 90^o flexion in hip and knee joint and 90^o in shoulder joint. I asked from patient to elevate right hand and hold it for 10s. Then I asked her to do the same with right hand, left leg and right leg. Elevated extremity had to be in the level of the spine. Repetition 12 times.
- Bridging - patient was lying supine with bending knees and she was pushing off the bed to raise her pelvis. Repetition 12 times.
- Soft tissue techniques on the scar - S-wave on the scar , C-wave on the scar ,hold and release on the scar, applying deep pressure on the scar.
- Exercise to improve the mobility of the spine in flexion, extension and lateroflexion. Patient is asked to be on all fours, with the whole spine in line with the head. Patient is slowly flexing her head to her cervical spine to her thoracic and then the lumbar spine. For lateroflexion, the patient is asked to look at her right heel by maintaining the straight position of the spine and by looking at her left heel. Finally for extension, patient is extending slowly her head back, extend her cervical spine to her thoracic and then the lumbar spine. Repetition 12 times.
- For improving the balance of patient I will let her walk slowly on a soft physiotherapeutic mattress without shoes.

3.7. Final Kinesiologic Examination

3.7.1. Postural Examination (plumb line test)

Anterior view:

Ankle joints are slightly in external rotation in both sides
Patellae are in the same level
Left triangle is smaller
Left shoulder is higher

Lateral view (right side):

Ankle, knees and hip are in good alignment
Slight protraction of shoulders
Head is shifted forward

Lateral view (left side):

Ankle, knees and hip are in good alignment
Slight protraction of shoulders
Head is shifted forward

Posterior view:

Slight external rotation of both feet
Popliteal lines are symmetrical
Gluteal lines are aligned
Pelvis is physiological without elevation
Left shoulder is higher
Head is positioned in midline

3.7.2. Dynamic Spine Tests

<u>Extension:</u>
The movement was performed without pain.
No restriction of movement.

Lateral flexion:

The movement was performed without pain.

The movement was slightly restricted in both sides.

The spinal curvatures were symmetrical.

The bigger movement was noticed in thoracic region.

3.7.3. Pelvic examination

Anterior iliac spines are on the same level.

Posterior iliac spines are on the same level.

Iliac crests are in alignment.

3.7.4. Gait Examination

The patient was walking in a good rhythm without any pain.

Her steps were symmetrical.

She had bigger swinging movement of her left hand.

Backward walking (Gluteal): The walking was performed with bigger movements in hands and bigger rotation in trunk.

Walking on heels (L5): She was able to perform it without pain.

Walking in tiptoes (S1): She was able to perform it without any difficulty.

Walking with bend knees (L4): The patient performed this modification of gait without difficulty.

3.7.5. Anthropometric Measurements

	Right Lower Extremity	Left Lower Extremity
Anatomical length	95cm	95cm
Functional length	100cm	100cm
Thigh circumference	53cm	50cm
Knee circumference	39cm	38cm
Calf circumference	35,5cm	35cm
Ankle circumference	25cm	25,5cm
Metatarsals circumference	21,5cm	22cm

Table 7: Anthropometric Measurements

3.7.6. Special Tests

Weight bearing test: Right-45Kg, Left-40Kg

Romberg test: Romberg test I , II and III negative.

Tredelenburg test: Negative for both sides.

Vele's test: Negative

3.7.7. Range of motion examination, according Kendall

	Right Lower Extremity		Left Lower Extremity	
Movement	Active	Passive	Active	Passive
Hip extension	10^0	10^0	10^0	10^0
Hip flexion	100^0	105^0	95^0	100^0
Hip abduction	40^0	45^0	40^0	45
Hip adduction	10^0	10^0	10^0	10^0
Hip external rotation	40^0	45^0	40^0	45^0
Hip internal rotation	40	45	40	45
Knee flexion	120^0	125^0	120^0	125^0
Knee extension	0^0	0^0	0^0	0^0
Ankle plantar flexion	40	45	40	45
Ankle dorsal flexion	20	20	20	20
Ankle inversion	35	45	35	45
Ankle eversion	15^0	20^0	10^0	15^0

Table 8: Range of motion examination

3.7.8. Muscle Length Examination, according Janda

Muscles	Right Lower Extremity	Left Lower Extremity
Iliopsoas	0	0
Hamstrings	0	0
Quadriceps	0	0
Gastrocnemius	0	0
Soleus	0	0

Table 9: Muscle Length Examination (Grade 0: no shortness was found)

3.7.9. Muscle Strength Examination, according Kendall

	Right Lower Extremity	Left Lower Extremity
Hamstrings	5	5
Quadriceps	5	5
Iliopsoas	5	5
Tensor fascia latae	4	4
Gluteus minimus	4^+	4^+
Gluteus medius	4^+	4^+
Gluteus maximus	4^+	4^+
Piriformis	4^+	4^+
Quadratus lumborum	4	4
Gastrocnemius	5	5
Soleus	5	5
Tibialis anterior	5	5
Peronius longus	4^+	4^+
Extensor hallucis longus	4	4
Flexor hallucis longus	5	5
Flexor hallucis brevis	5	5
Plantar interossei	5	5
Dorsal interossei	5	5
Rectus abdominis	4	

Table 10: Muscle Strength Examination

3.7.10. Palpation Examination

	Right side			Left side		
Muscles	Pain	Tonus	TrPs	Pain	Tonus	TrPs
Hamstrings	No	Normal	No	No	Normal	No
Quadriceps	No	Normal	No	No	Normal	No
Tensor fascia latae	No	Normal	No	No	Normal	No
Gluteus medius	No	Normal	No	No	Normal	No
Gluteus maximus	No	Normal	No	No	Normal	No
Iliopsoas	Slight	Normal	No	Slight	Normal	No
Piriformis	Yes	Normal	No	Yes	Normal	No
Gastrocnemius	No	Normal	No	No	Normal	No
Soleus	No	Normal	No	No	Normal	No
Tibialis anterior	No	Normal	No	No	Normal	No
Rectus abdominis	No	Slight Hypotonic	No	No	Slight Hypotonic	No
Quadratus lumborum	Slight	Normal	No	Slight	Normal	No

Table 11: Palpation Examination

3.7.11. Joint Play Examination, according Lewit

Joints	Directions	Right side	Left side
Sacroiliac joint	Springing test Stoddard	Unblocked	Unblocked
Head of fibula	Dorsal Ventral	Unblocked Unblocked	Unblocked Unblocked
Tibiofibular joint	Internal rotation External rotation	Unblocked Unblocked	Unblocked Unblocked
Patella	Cranial Caudal Lateral Medial	Unblocked	Unblocked

Lisfranc	Plantar Dorsal	Unblocked	Unblocked
Talocrural	Dorsal	Unblocked	Unblocked

Table 12: Joint Play Examination

3.7.12. Neurologic Examination

Superficial sensation in dermatomes:

L1, L2,L3,L4, L5, S1, S2

Patient had sensation in all dermatomes and she had the same sensation in both legs.

Deep sensation:

Position sense: Heel along tibia, the patient was able to perform it.

Patellar reflex (L2-L4):

Present in both sides.

Achilles tendon reflex (S1):

Present in both sides.

3.7.13. Soft Tissue Examination, according Lewit

I couldn't examine the patient's scar because of the stitches and the bandages.
The mobility of skin, sub-skin and fascias around the scar was good.
The mobility of skin, sub-skin and fascias on thoracic and cervical area are normal.

3.7.14. Movement Pattern Evaluation, according Janda

Hip extension: Patient performed the movement pattern very well. The activation sequence of the muscles was correct in both sides.

Hip abduction: There was good activation of gluteus medius and minimus. The movement was pure abduction without any flexion of hip joint.

3.8. Evaluation of the effect of the therapy

I believe that the therapy sessions helped in the improvement of my patient stage. My patient was very cooperative and she could perform without any difficulty all the exercises I showed her. The exercises I used didn't provoke any pain. After every therapy session she was feeling relaxed and the pain that she was complaining about was decreased. Very satisfying result was the final muscle strength examinations especially for abdominal muscles from 3 to 4 rate in the muscle strength scale, I could see the difference of the muscles strength also in the performance of the exercises. Piriformis muscle had normal tone after palpation. In addition fascia in lower back wasn't stiff. The range of movement in all joints (hip,knee,ankle) was increased. In hip flexion there was an increase of 15^{o} in both sides, the hip abduction and internal rotation had an increase of 5^{o} in both sides. Changes were also noticed in ROM of the ankle plantar flexion and dorsal flexion where there was 5^{o} of increase in both sides. In addition the length of hamstrings muscle had an improvement day by day due to the stretching. The circumference of left thigh increased in comparison from the beginning of the examination. The posture of my patient was also improved, after the therapies my patient had an upright position and less kyphotic. Although there is still slight external rotation of the ankles in both sides.My patient was in a good condition because of the sportsshe takes part in, that's why it wasn't difficult for her to exercise. I believe that in the future she will not have any problems with her back. In conclusion of this final kinesiological examination, there are some slight improvements of all the aspects.

	Right Lower Extremity Active movement		Left Lower Extremity Active movement	
Movement	Before treatment	After treatment	Before treatment	After treatment
Hip flexion	85^{0}	100^{0}	80^{0}	95^{0}
Hip abduction	35^{0}	40^{0}	35^{0}	40^{0}
Hip internal rotation	35^{0}	40^{0}	35^{0}	40^{0}
Ankle plantar flexion	35^{0}	40^{0}	35^{0}	40^{0}

Ankle dorsal flexion	15^0	20^0	15^0	20^0
Ankle inversion	30^0	35^0	30^0	35^0

Table 13: Changes of range of motion before and after treatment

Muscles	Right Lower Extremity		Left Lower Extremity	
	Before treatment	After treatment	Before treatment	After treatment
Hamstrings	1	0	1	0

Table 14: Lengthening changes before and after treatment for hamstring muscle

	Right Lower Extremity	Left Lower Extremity	Right Lower Extremity	Left Lower Extremity
	Befor treatment		After treatment	
Hamstrings	4^+	4^+	5	5
Quadriceps	4^+	4^+	5	5
Iliopsoas	4^+	4^+	5	5
Tensor fascia latae	4	4	4	4
Gluteus minimus	4	4	4^+	4^+
Gluteus medius	4	4	4^+	4^+
Gluteus maximus	4	4	4^+	4^+
Piriformis	4^-	4^-	4^+	4^+
Quadratus lumborum	4	4	4	4
Gastrocnemius	5	5	5	5
Soleus	5	5	5	5
Tibialis anterior	4^+	4^+	5	5
Peronius longus	4^+	4^+	4^+	4^+
Extensor hallucis longus	4	4	4	4

Flexor hallucis longus	5	5	5	5
Flexor hallucis brevis	5	5	5	5
Plantar interossei	5	5	5	5
Dorsal interossei	5	5	5	5
Rectus abdominis	3		4	

Table 15: Strengthening changes of muscles before and after the treatment

	Right side			Left side		
	Before treatment					
Muscles	Pain	Tonus	TrPs	Pain	Tonus	TrPs
Gluteus maximus	No	Hypotonic	No	No	Hypotonic	No
Iliopsoas	Slight	Normal	No	Slight	Normal	No
Piriformis	Yes	Hypertonic	No	Yes	Hypertonic	No
Rectus abdominis	No	Hypotonic	No	No	Hypotonic	No
Quadratus lumborum	Slight	Normal	No	Slight	Normal	No
	Right side			Left side		
	After treatment					
Muscles	Pain	Tonus	TrPs	Pain	Tonus	TrPs
Gluteus maximus	No	Normal	No	No	Normal	No
Iliopsoas	Slight	Normal	No	Slight	Normal	No
Piriformis	Yes	Normal	No	Yes	Normal	No
Rectus abdominis	No	Slight Hypotonic	No	No	Slight Hypotonic	No
Quadratus lumborum	Slight	Normal	No	Slight	Normal	No

Table 16: Changes in muscle tone before and after treatment

4. Conclusion

I believe that the therapy sessions helped in the improvement of my patient stage. My patient was very cooperative and she could perform without any difficulty all the exercises I showed her. The exercises I used didn't provoke any pain. After every therapy session she was feeling relaxed and the pain that she was complaining about was decreased. Very satisfying result was the final muscle strength examinations. Piriformis muscle had normal tone after palpation. In addition fascia in lower back wasn't stiff. Moreover the soft tissue on the scar and around the scar improved.

4.1. Prognosis

After the therapy my patient had sufficient changes according the final examination results. It's now on my patient's hand to keep improving and do not experience any back pain again. According my patients attitude and character I believe that she will get better and stronger every day and hopefully she will not face again the same problem

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6. Supplements

6.1. Ethical Board

6.2 INFORMOVANÝ SOUHLAS

6.3. List of pictures

Picture 1: Spinal column lateral view

Picture 2: Ligaments and intervertebral discs

Picture 3: Spinal nerves

Picture 4: Superficial muscles of the back

Picture 5: Intermediate muscles of the back

Picture 6: Deep muscles of the back

Picture 7: MRI slide showing disc protrusion

6.4. List of tables

Table 1: Anthropometric measurements – Initial Kinesiologic Examination

Table 2: Range of motion examination - Initial Kinesiologic Examination

Table 3: Muscle length examination - Initial Kinesiologic Examination

Table 4: Muscle strength examination - Initial Kinesiologic Examination

Table 5: Palpation examination - Initial Kinesiologic Examination

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Table 7: Anthropometric measurements – Final kinesiologic examination

Table 8: Range of motion examination - Final kinesiologic examination

Table 9: Muscle length examination – Final Kinesiologic Examination

Table 10: Muscle strength examination - Final Kinesiologic Examination

Table 11: Palpation examination - Final Kinesiologic Examination

Table 12: Joint play examination – Final kinesiologic examination

Table 13: Changes of range of motion before and after treatment

Table 14: Lengthening changes before and after treatment for hamstrings muscle

Table 15: Strengthening changes of muscles before and after treatment

Table 16: Changes in muscle tone before and after treatment